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CONTRIBUTIONS TO THE STRATIGRAPHY OF THE ALLEGHENY SERIES IN COLUMBIANA AND MAHONING COUNTIES, OHIO

PART I. STRATIGRAPHY AND CORRELATION OF THE COALS AND LIMESTONE BELOW THE LOWER KITTANNING COAL

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The general stratigraphic section and many of the details of the geology of Columbiana and Mahoning Counties are known from the published reports of Newberry, Orton, Stout and Lamborn, and others. As time goes on, however, new data that add to the already existing store of geologic knowledge or that necessitate some minor revision of the present correlation of the various strata are discovered. Some years ago I began the study of the invertebrate fossils of the Allegheny Series in that portion of these two counties within the Lisbon Quadrangle, and as the study has progressed some new facts concerning the stratigraphy have been found. It is proposed to present this new information in three separate parts under the general title given above (see Fig. 1):

Part I. Stratigraphy and Correlation of the Coals and Limestone below the Lower Kittanning Coal.

Part II. Stratigraphy of the Middle Kittanning Coal between Greenford and Washingtonville, Ohio.

Part III. Stratigraphy, Petrology, and Paleontology of the Salem Limestone.

LOCATION

There are two coals and one shaly marine limestone below the Lower Kittanning coal and above drainage in the northeastern quarter of the Lisbon Quadrangle. The limestone is closely associated with the lowermost coal, and these two members occur in Sections 4, 7, and 18, Green Township, Mahoning County. Other exposures of the same members are known further north in the adjacent Warren Quadrangle, and this same coal without the overlying shaly limestone may be present along Little Beaver Creek south of New Albany.

The Lower Kittanning coal is 25 to 35 feet higher than the above members, and a few inches to several feet below the base of the Lower Kittanning coal is the second coal which is normally thin and irregular in distribution. This second coal is present in localities under consideration at present from the northern edge of the Lisbon Quadrangle at least as far south as Section 15, Salem Township, and also at Coleman in Section 9, Center Township, Columbiana County. It is reasonably certain that the lowermost coal and the limestone are the Clarion and Vanport members, respectively, and the coal occurring just below the Lower Kittanning coal is without doubt the Lawrence coal.

The various known localities of these three members in this vicinity are shown in Figure 2, and the stratigraphic sections are plotted in Figure 4.

STRATIGRAPHY

Clarion Coal and Vanport Limestone.—Lamb, who was apparently the first to observe and mention the Vanport limestone in this area, described it in 1910 under the name of Howenstein limestone on the Ira Unger farm along a tributary to

Fig. 1. Map of Ohio showing location of Columbiana and Mahoning counties and the Lisbon and surrounding quadrangles.

Meander Creek in the northwest quarter, Section 4, Green Township, Mahoning County.[1] The strata along this small stream are of special interest; for there are two closely associated coal beds further upstream on the John Ewing (now

[1]Lamb, G. F.: *Pennsylvanian Limestones of Northeastern Ohio below the Lower Kittanning Coal*, Ohio Naturalist, vol. 10, pp. 115–117. (1910.)

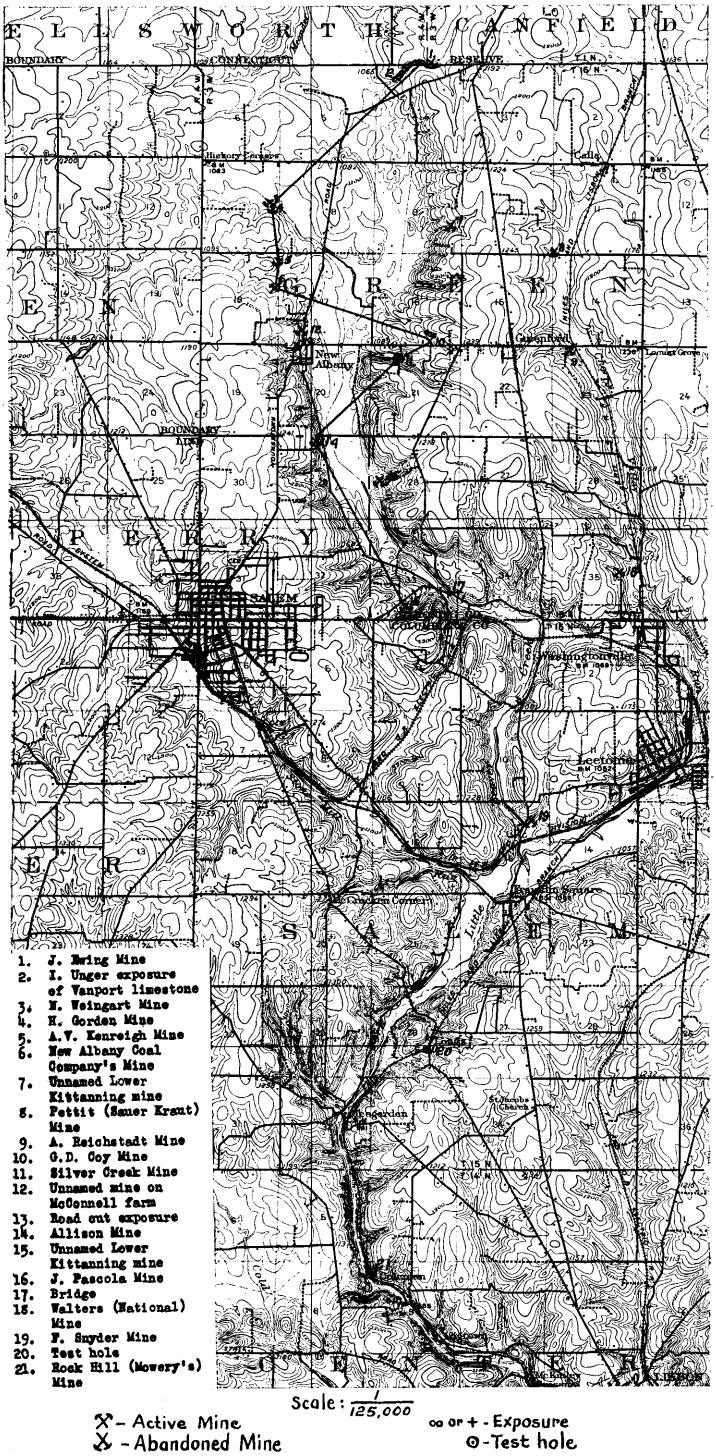

Fig. 2. Northeastern portion of the Libson Quadrangle showing locations of stratigraphic sections described in the text and shown in the correlation diagram (Fig. 4).

Ray Hagstrom) farm in the southwest corner of Canfield Township, Mahoning County. These two coals were formerly mined, although the lower coal was of very poor quality (See Figure 3A). Mining probably began before 1878, for in that year Newberry wrote as follows:[2]

"On the Erving farm, in the southwest corner of Canfield (township) it is two and a half feet thick, two feet bituminous, and six inches of the upper part cannel. Here another coal seam two feet thick, probably Coal No. 3a, lies about eight feet under it, but the interval is usually much greater."

Although Newberry wrote "Erving" instead of "Ewing," the location and description given are those of the locality under discussion.

Orton visited the locality when the mining of the upper coal was still in progress, and identified it as the Canfield Cannel or Scrub Grass or Upper Clarion coal in 1884.[3] Orton's interpretation would identify the lower coal as the Clarion as recognized in the standard section for the Pennsylvanian System by the present Geological Survey of Ohio.[4] The mines are long since abandoned (See Fig. 3B) and only the upper coal can be seen in very limited exposures near the old mine entrance and along the adjacent road. In August, 1938, I visited this valley and with the help of information from Mr. Elmer Ewing and Mr. Ira Unger determined the following section and interpretation of it:

15.	Glacial till			19′ 6″
14.	"Draw slate"			1′ 6″
13.	Coal: cannel	*Lower Kittanning*		0′ 5″
12.	Coal: bituminous	*Lower Kittanning*		1′ 10″
11.	Clay: plastic			7′ 0″
10.	Shale			1′ 0″
9.	Coal: bituminous, poor quality, *Lawrence*			1′ 10″ to 3′ 2″
8.	Clay: plastic (?)			
7.	Shale: gray, arenaceous, with few plant fossils			9′ 0″
6.	Shale and sandstone: upper 15–18 feet consists largely of gray, fine grained, thin bedded, and micaceous sandstone with some interbedded shale layers, lower part is gray, arenaceous, and micaceous shale with layers or lenses of fine grained sandstone up to several feet in thickness			30′ 0″
5.	Shale: gray, fossiliferous, with clay ironstone concretions	*Vanport*		3′ 9″
4.	Limestone: dark gray to black, somewhat flinty in appearance, but actually not siliceous, shaly appearance on weathering, fossiliferous	*Vanport*		1′ 6″
3.	Shale: dark gray, fossiliferous, with 1-inch ferruginous layer at top, exposed	*Vanport*		1′ 6″
2.	Covered interval			17′ 6″
1.	Coal: reported to be thin, *Clarion*.			

[2]Newberry, J. S.: *Report on the Geology of Mahoning County*, Geol. Surv. Ohio, vol. III, pp. 795–796. (1878.)

[3]Orton, Ed.: *The Stratigraphical Order of the Lower Coal Measures of Ohio*, Geol. Surv. Ohio, vol. V, pp. 31 and 34. (1884.)

[4]Bownocker, J. A., and Dean, E. S.: *Analyses of the Coals of Ohio*, Geol. Surv. Ohio, 4th series, Bull. 34, chart opposite p. 6. (1929.)

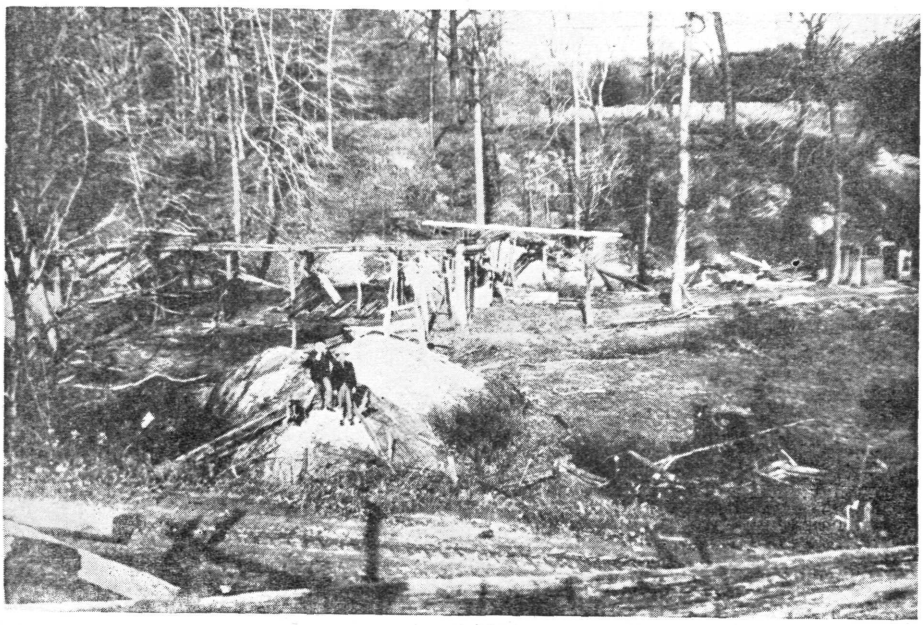

Fig. 3. A. The Ewing Mine from the south side at about the time of its abandonment in 1908 or 1909. The white line marks the approximate dip of the Lower Kittanning coal toward the east, and the arrow points to the entrance of the slope to the Lawrence coal. The two men are John (left) and Elmer Ewing. Original photo by Herbert Knauf; reproduced here through the courtesy of Elmer Ewing.

Fig. 3. B. The above location today (May, 1943) from the southeast. The young man is standing on the same mound that the Ewings are in the above picture.

The Clarion coal is not exposed and is reported by Mr. Unger from a test drill hole. Orton reported fragments of a blue fossiliferous limestone above the cannel coal, and if these fragments were in place, they undoubtedly represent the Hamden limestone.

Mr. Nick Weingart formerly operated a small mine on the Clarion coal on the north side of the Little Beaver Creek in the east-central part of Section 7, Green Township, Mahoning County. I measured the following section in December, 1932:

7.	Shale: dark gray, argillaceous, sparingly fossiliferous, exposed		1′ 8″
6.	Shale: similar to zone 5 but thinner bedded, very fossiliferous	*Vanport*	0′ 10″
5.	Shale: dark gray to black, very fossiliferous; with an almost continuous layer of pyritiferous and fossiliferous limestone nodules		0′ 4″
4.	Coal: with numerous thin discontinuous marcasite partings and with calcite in joints near the top, *Clarion*		1′ 6″
3.	Clay: light gray with buff stain, plastic, arenaceous toward base		5′ 10″
2.	Shale: light gray with buff stain, arenaceous, grades into plastic clay above, exposed		2′ 0″
1.	Level of Little Beaver Creek.		

This locality was excellent for collecting invertebrate fossils, especially gastropods, cephalopods, and brachiopods.

On the farm of Harry Gordon across Little Beaver Creek from the abandoned Weingart mine I measured the following section in an abandoned mine entrance and a nearby wash in September, 1938:

10.	Shale: gray to buff, arenaceous; with numerous clay ironstone concretions, exposed		16′ 0″
9.	Shale: gray, fossiliferous	*Vanport*	2′ 6″
8.	Shale: dark gray to black, flinty in appearance, sparingly fossiliferous		1′ 0″
7.	Shale: dark gray, sparingly fossiliferous		5′ 0″
6.	Shale: gray, similar to but lighter gray than shale of zone 5, fossiliferous at least in basal part		7′ 6″
5.	Shale: dark gray, argillaceous, fossiliferous		3′ 0″
4.	Limestone: dark gray, shaly, fossiliferous		0′ 6″
3.	Shale: dark gray, fossiliferous		1′ 9″
2.	Coal: *Clarion*		1′ 6″
1.	Clay: plastic, unmeasured.		

A similar section but one that is less well known in detail occurs on the A. V. Kenreigh farm almost on the boundary between the northwest quarter and northeast quarter of Sections 17 and 18, respectively, Green Township, Mahoning County. There the exposure is along the channel of a small intermittent stream and in two shallow shafts that were dug several years ago to prospect the Clarion coal. The shafts were partly filled by water when visited in 1939, and the following section was determined partly by studying the refuse piles and the exposures along the stream and partly by information given by Mr. Kenreigh:

5.	Shale: weathered, unmeasured.		
4.	Limestone: dark gray to black, fossiliferous, similar in lithology to limestone on the Unger farm.....	*Vanport*.....	1′ 4″
3.	Shale: blue gray, fossiliferous; with small scattered clay ironstone concretions; thickness approximate...		8′ 0″
2.	Limestone: dark gray, nodular, fossiliferous.....		0′ 4″
1.	Coal, *Clarion*.....		1′ 0″

It is assumed that the nodular limestone lies directly on the coal, as some of the nodules which are in the refuse piles have bits of coal adhering to them in the

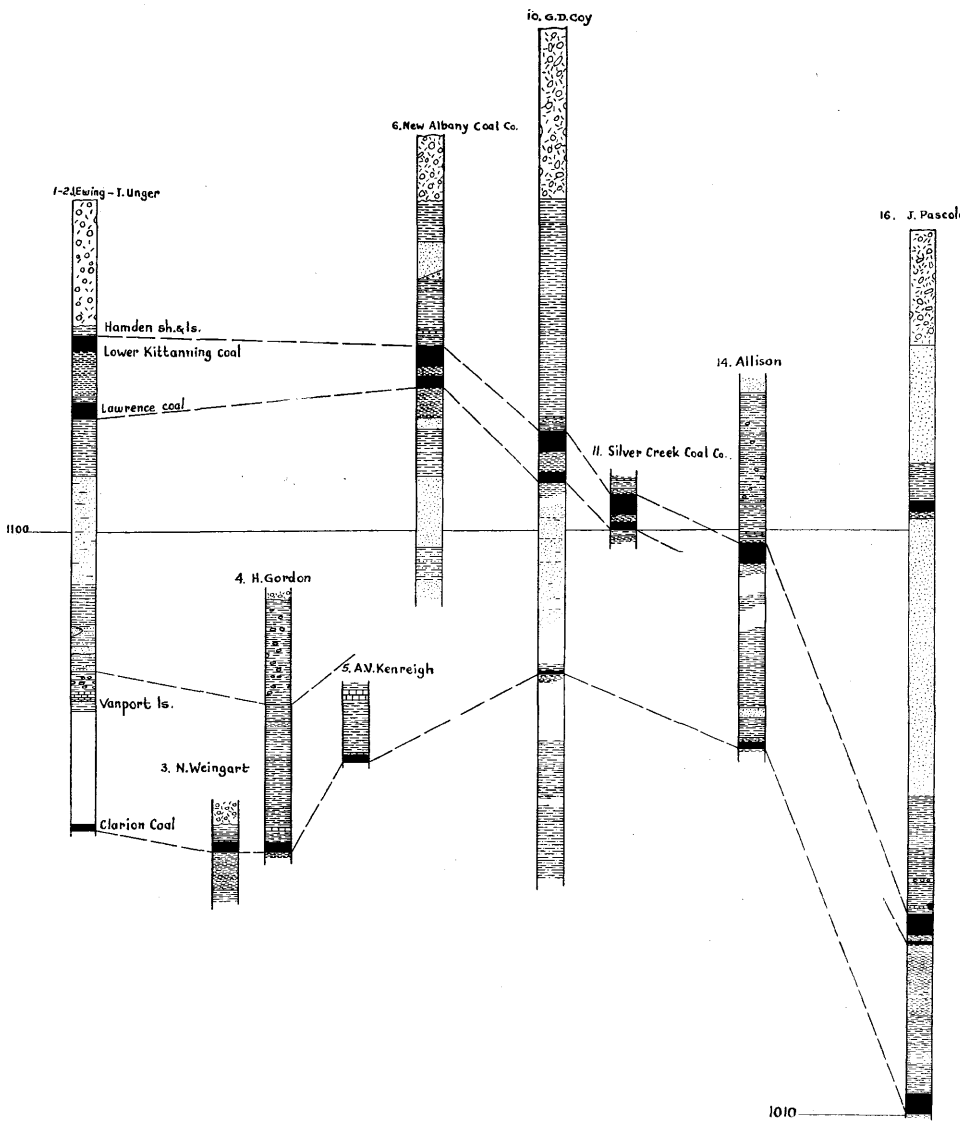

Fig. 4. Correlation diagram of the strata below the Lower Kittanning coal in the northeastern part of the Lisbon Quadrangle.

same manner as those at abandoned Weingart mine. It is reported by Mr. Kenreigh that the limestone, No. 4, in the above section was burned by his grandfather for lime almost a century ago and that mounds still mark the sites of those burnings.

It is evident from these four sections that the Vanport member is represented by a considerable thickness of fossiliferous shale with variable interbedded nodular or shaly limestone overlying the Clarion coal. This thickness reaches a known maximum at the abandoned mine on the Harry Gordon farm with a total of 21 feet. On the Kenreigh farm the known thickness is about 10 feet, and it is probable that the weathered shale on top of the limestone is also fossiliferous. The entire thickness of shale and limestone at the abandoned Weingart mine contains fossils but only 2 feet and 10 inches are exposed. There are 6 feet and 9 inches of fossiliferous strata exposed on the Unger farm, but if the 17 feet and 6 inches of strata overlying the coal below drainage are fossiliferous, the thickness of fossiliferous strata would be in excess of 24 feet. These sections are similar in lithology and of even greater thickness than those of the Vanport member described by Stout and Lamborn in Elk Run and St. Clair Townships, Columbiana County.[5]

As far as known there are no exposures of the Vanport member along Little Beaver Creek south of the exposure on the Kenreigh farm, but it may be covered by mantle rock along the lower slopes of the valley sides. In addition to the sections with the Vanport member there are four locations of coal, probably Clarion, known in this vicinity.

A short distance north of New Albany between the old and new locations of Route 62 at the buildings of the D. McConnell farm a shallow shaft to a coal below the Lower Kittanning coal was in operation during the First World War. This shaft has been abandoned and filled, and to date I have been unable to get any detailed information concerning it. It is reasonably certain that the Clarion coal was the coal mined in this shaft. Evidence concerning the presence of the Vanport member is wanting.

The other three are exposures, the first of which is located in a ravine near the New Albany-Greenford road in the southeast quarter of Section 16, Green Township, Mahoning County. The section here and in the nearby abandoned G. D. Coy shaft mine is as follows:

18.	Glacial till: cribbed		25′ 0″
17.	Shale: gray, weathered		4′ 0″
16.	Shale: gray		30′ 0″
15.	Shale: gray, fossiliferous; with nodules of fossiliferous limestone, thickness variable	*Hamden*	1′ 0″
14.	Shale: black, bony, fossiliferous		1′ 3″
13.	Coal, *Lower Kittanning*		3′ 0″
12.	Clay: gray, plastic		3′ 4″
11.	Coal, *Lawrence*		1′ 6″
10.	Clay: plastic, unmeasured.		
9.	Sandstone: gray or stained buff, fine, friable, micaceous, bedded; with shaly layers and lenses		20±′
8.	Covered interval		6′ 0″
7.	Shale: gray, weathered, exposed		1′ 0″
6.	Coal, *Clarion*		0′ 4″
5.	Clay: gray, arenaceous, plastic, exposed		1′ 0″

[5]Stout, W., and Lamborn, R. E.: *Geology of Columbiana County*, Geol. Surv. Ohio, 4th series, Bull. 28, pp. 68–70. (1924.)

4.	Covered interval		9′ 3″
3.	Shale: gray; with clay ironstone concretions, exposed		9′ 1″
2.	Covered interval		1′ 2″
1.	Shale: gray, arenaceous, exposed		11′ 0″

The interval between the base of the Lower Kittanning coal and the top of the Clarion coal is a little more than 30 feet. No evidence of the Vanport member can be seen, but the exposure is poor. At places in the Coy mine there is a thin layer of cannel coal at the top of the Lower Kittanning coal. This is most common toward the eastern edge of the lease and in the swamps where the coal is thickest. The Hamden member is everywhere marine.

The Clarion coal is exposed at a little abandoned mine on the Allison farm in the northwest quarter, Section 29, Perry Township, Columbiana County. The section exposed here in September, 1938, is as follows:

14.	Sandstone: gray, thin bedded, micaceous, exposed		2′ 0″
13.	Shale: gray, arenaceous and ferruginous; with numerous clay ironstone concretions		17′ 0″
12.	Shale: light gray, argillaceous, soft		0′ 9″
11.	Shale: dark gray, fossiliferous	*Hamden*	3′ 6″
10.	Shale: dark gray, very fossiliferous; with fossiliferous limestone nodules	*Hamden*	1′ 0″
9.	Shale: black, bony, fossiliferous	*Hamden*	0′ 9″
8.	Coal, *Lower Kittanning*		3′ 0″
7.	Clay: plastic	partly covered	22′ 4″
6.	Shale: ?	partly covered	
5.	Sandstone: gray weathering buff, a single ledge showing bedding on weathering		1′ 5″
4.	Shale: gray and buff, arenaceous, thickness variable		3′ 0″
3.	Clay-shale: light and dark, soft		0′ 8″
2.	Coal, *Clarion*		0′ 10″
1.	Clay: plastic; unmeasured.		

There are 27 feet and 5 inches between the base of the Lower Kittanning coal and the top of the Clarion coal in this section. It is possible that there may be fossils in the partly covered shale, zone 6 of the section, but none were seen.

John Pascola formerly operated a shaft mine under the name of the New Salem Coal Company on the south side of the Salem-Washingtonville road (Route 14) in the southern part of Section 33, Green Township, Mahoning County. Four coals are shown in this shaft and a slope which extends 24 feet deeper than the base of the shaft. The entire section measured in March, 1933, in this mine is given below:

18.	Cribbing	17′ 6″
17.	Sandstone: massive, *Lower Freeport*	18′ 0″
16.	Shale: dark gray	6′ 0″
15.	Coal, *Middle Kittanning*	1′ 6″
14.	Clay: plastic	1′ 0″
13.	Sandstone	43′ 0″
12.	Shale: gray, argillaceous	12′ 6″

11.	Shale: gray, argillaceous, fossiliferous; with many clay ironstone concretions	*Hamden*	0′ 6″
10.	Shale: gray, argillaceous, fossiliferous; with few clay ironstone concretions		3′ 6″
9.	Shale: dark gray, calcareous, very fossiliferous; with fossiliferous limestone nodules		1′ 0″
8.	Shale: black, bony, fossiliferous		0′ 6″
7.	Coal: contains thin partings of marcasite, one of which near the top is about 1 inch thick and fairly persistent, *Lower Kittanning*		3′ 2″
6.	Clay: gray or gray-drab, plastic		1′ 0″
5.	Coal: locally present, *Lawrence*		0′ 5″
4.	Clay: gray, plastic		11′ 0″
3.	Shale: gray, arenaceous; with some clusters of clay ironstone concretions.		12′ 0″
2.	Coal: interbedded with thin lensing layers of shale containing plant fossils	*Clarion*	0′ 3″
1.	Coal: contains numerous thin shaly partings. One of these partings is an inch or so in thickness near the base of the thicker portions of the coal		2′ 8″

It is certain that there are no marine fossils in the shale overlying the Clarion coal in this section. An attempt was made to mine the Clarion coal here, but while it was of sufficient thickness, the quality was such that the attempt was soon abandoned. It is reported that a bed of coal was exposed in the channel of Little Beaver Creek about one-half mile northeast of the Pascola shaft when the highway bridge was built at that point a few years ago. If this is true, the coal is also the Clarion member.

At Long's Crossing located five miles south of the Pascola shaft in the southeast quarter, Section 28, Salem Township, Columbiana County, the Clarion member is absent but the underclay is apparently present as shown in a test hole drilled from near the base of the Upper Freeport coal to a depth of 253 feet. A record of this test hole is available through the courtesy of Mr. Homer Callahan, and the portion of the record from the Lower Kittanning coal to the Clarion clay is given:

10.	Coal, *Lower Kittanning*	2′ 8″
9.	Clay	4′ 4″
8.	Shale: gray	3′ 6″
7.	Clay	2′ 6″
6.	Shale: gray	7′ 0″
5.	Shale: brown	3′ 0″
4.	Shale: gray	4′ 0″
3.	Sandstone: gray; with streaks of shale	12′ 0″
2.	Clay, *Clarion* (?)	2′ 0″
1.	Sandstone and shale: gray	30′ 0″

The interval between the Lower Kittanning coal and the Clarion clay is about 36 feet.

The Allison and Pascola sections show that the Clarion coal is present along Little Beaver Creek as far south as the Columbiana-Mahoning county line east of the City of Salem. Thus the Clarion coal is present for a distance of six miles from the northern to southern boundaries of Green Township, Mahoning County, along the headwaters of Meander Creek and Little Beaver Creek, and in the northern two miles of this extent the associated Vanport member is also present. In this area the Clarion coal has been prospected and mined to a very limited extent, but it had practically no economic value in the past and promises to have little in the future because of its irregular and thin development and because

of its poor quality. The Vanport member has been used to a very limited extent for agricultural lime in times past, but its shaly and impure character give little or no promise for future uses. Both the Clarion and Vanport members are useful to the stratigrapher in determining the complete stratigraphic section of this area.

The Lawrence Coal and Clay.—In 1938 when test drillings were made preparatory to opening the New Albany Coal Company's strip mine on the Lower Kittanning coal in Sections 17 and 18 of Green Township, Mahoning County, the promoters were surprised to discover a second coal lying almost directly beneath the Lower Kittanning coal in that area. The local miners had various names and numbers for this lower coal, but it is without question the Lawrence coal, the normal position of which is several feet below the Lower Kittanning coal.[6] This Lawrence coal is present as a thin, impure, and irregular bed with a discontinuous distribution in the northeastern portion of the Lisbon quadrangle. It may be more commonly present than is usually suspected. I have made no systematic effort to locate all known localities of occurrence within the area, but a number have come to my attention.

The Lawrence coal is present in the previously described sections on the Ewing and Unger farms and in the Coy and Pascola shafts. Orton mentions three sections in which the Lawrence coal is present in addition to the Ewing locality.[7] It is well exposed in the New Albany Coal Company's strip mine mentioned above, where J. O. Fuller and I determined the following composite section along the face of the mine and in a drainage ditch in 1941:

19.	Glacial till		10′ 0″
18.	Shale: brown, arenaceous, exposed		6′ 0″
17.	Sandstone: light gray, medium to coarse, micaceous, bedded		4′ 6″
16.	Sandstone: lens of bluish gray, quartzitic-appearing sandstone, with disconformable and conglomeratic base that has pebbles of local origin; grades laterally and upward into above sandstone, thickness variable		1′ 6″
15.	Shale: dark gray, pyritiferous		2′ 0″
14.	Shale: dark gray, fossiliferous; with few clay ironstone concretions	*Hamden*	6′ 0″
13.	Shale: dark gray, fossiliferous; with nodular fossiliferous limestone at top		0′ 10″
12.	Shale: black, bony, fossiliferous		1′ 6″
11.	Coal: with partings of marcasite and fusain	*Lower Kittanning*	2′ 8″
10.	Coal: impure, with much marcasite and fusain		0′ 3″
9.	Clay: gray to dark gray, plastic		1′ 6″
8.	Coal: impure; with much marcasite and fusain	*Lawrence*	1′ 4″
7.	Shale: dark gray, carbonaceous, with streaks of marcasite and coal, weathers yielding sulphur		0′ 4″
6.	Clay: light gray, plastic, arenaceous, especially in lower part		4′ 6″
5.	Sandstone: white weathering buff, fine, micaceous, thin-bedded		2′ 0″
4.	Shale: dark gray, micaceous, arenaceous; with thin layers of sandstone and apparently grading laterally into sandstone		7′ 0″
3.	Sandstone: light gray, platy, micaceous, carbonaceous, irregularly bedded		11′ 0″
2.	Shale and sandstone: gray to dark bluish gray, micaceous, arenaceous and carbonaceous shale with irregular layers and lenses of shaly, micaceous, and carbonaceous sandstone, thickness variable		5′ 0″
1.	Sandstone: gray weathering yellowish, medium, micaceous, massive, exposed		3′ 0″

[6]Bownocker, J. A., and Dean, E. S.: *Op. Cit.*, chart opp. p. 6 and p. 53.
[7]Orton, Ed.: *Op. cit.*, pp. 32, 33, 180, and 194.

The strata in this strip mine are irregular. There is an apparent dip of seven degrees in the beds exposed along the drainage ditch. The Lower Kittanning coal rises and falls as much as 30 feet in distances of 200 feet in the mine. The coal has thickness up to 42 inches in the swamps but only averages about 18 inches and may even run out on the swells. The Hamden member is considerably thicker and much more massive appearing in the swamps.

The Lower Kittanning and Lawrence coals can be seen in similar relationship along Route 62 in the road cut in New Albany. The localities of Lower Kittanning and Lawrence coals cited by Orton are in the now abandoned Pettit mine at Cook's Crossing one mile north of Greenford in Section 11, Green Township, and at the now abandoned Walters mine in Section 35, Green Township, Mahoning County.[8] At both places he believed that the upper coal was the Canfield cannel coal which he correlated as the Upper Clarion or Scrub Grass member and that the lower coal was the Clarion member. He was correct in correlating the upper coal with the Canfield cannel coal which is now known to be the Lower Kittanning coal, and the lower coal is now named the Lawrence coal. The limestone overlying the upper coal which Orton believed to be the Ferriferous or Vanport, is, of course, the Hamden member. Orton was undoubtedly led astray in his very logical interpretation by several facts, viz.: (1) the strongly undulatory character of the Lower Kittanning coal in the New Albany, Greenford, and Cook's Crossing areas where it rises and falls 30 feet at least in a horizontal distance of a couple of hundred feet, (2) the local absence of the Lawrence coal, (3) and the lack of knowledge at that time that fossiliferous marine limestone and shale of the Hamden member overlie the Lower Kittanning coal in this area. He believed that he recognized the Lower Kittanning coal in the old Reichstadt mine near Greenford in Section 23, Green Township, Mahoning County, where the thickness of 2½ feet of bituminous coal is overlaid by 4 to 6 inches of cannel coal. My latest studies have showed that the Reichstadt coal is probably the Middle Kittanning coal.[9] This feature of a small thickness of cannel coal overlying a considerable thickness of bituminous coal is also true for Lower Kittanning coal at several localities northward from Greenford. Orton reported this to be the condition in the Pettit mine at Cook's Crossing in Section 11, Green Township and at the Ewing mine in the southwest corner of Canfield Township, Mahoning County.[10] A similar relationship is present at places in the now abandoned G. D. Coy shaft in the southeastern corner of Section 16, Green Township, as shown in one of the previous sections and as reported by Lamborn.[11] In the southeastern quarter of Section 9, Green Township, the same relationship can be seen in the following section of the Lower Kittanning coal exposed in 1932 at the entrance of an abandoned mine:

6.	Shale: dark, weathered, exposed		2′	0″
5.	Shale: gray to black, bony		0′	6″
4.	Shale: gray to black, fossiliferous	*Hamden*	1′	6″
3.	Shale: black, bony, fossiliferous (?)		0′	7″
2.	Coal: cannel	*Lower Kittanning*	0′	4″
1.	Coal: bituminous		3′	8″

It should be noted that the nodular limestone of the Hamden member is absent

[8] *Idem.*, pp. 32–33 and 180–181.

[9] Sturgeon, M. T.: *The Stratigraphy of the Middle Kittanning Coal between Greenford and Washingtonville, Ohio* (in preparation).

[10] Orton, Ed.: *Op. cit.*, pp. 31 and 32.

[11] Lamborn, R. E.: *The Coal Beds in Southeastern Mahoning County*, Geol. Surv. Ohio, 4th series, Bull. 43, p. 30. (1942.)

in this section, but such absence occurs at other localities in this general area. The coal is somewhat thicker than average.

These several sections indicate that northward from Greenford the Lower Kittanning coal grades into the Canfield cannel coal.

The Lawrence coal is also represented in the section exposed at the entrance of the abandoned Silver Creek mine and in the nearby creek in the northwest quarter, Section 21, Green Township, Mahoning County:

8.	Shale: dark gray, fossiliferous with large nodules of fossiliferous limestone, weathered	*Hamden*	1′	3″
7.	Shale: black, bony, fossiliferous		1′	1″
6.	Coal: with many large flattened concretions of marcasite, *Lower Kittanning*		3′	0″
5.	Clay: gray to dark gray or black, carbonaceous and shaly		1′	2″
4.	Coal: good	*Lawrence*	1′	2″
3.	Coal: impure, bony; with numerous plant fossils		0′	2″
2.	Shale: dark gray, carbonaceous, with very thin lenses of coal		0′	10″
1.	Clay: light gray, plastic, arenaceous, exposed		1′	0″

The above section is not only similar to the section in the New Albany Coal Company's mine but also to those cited below by Orton.

There are probably numerous other localities at which the Lawrence coal is present, but most of them are not known first hand to me. At a small mine opening to the Lower Kittanning coal in the west-central part, Section 28, Green Township, Mahoning County, there are a few inches of Lawrence coal in the clay underlying the Lower Kittanning coal. In a shaft mine located in the northeast quarter of Section 15, Salem Township, the clay underlying the Lower Kittanning coal is reported by Mr. Francis Snyder to have a thin parting of coal. About five miles further south at Robbinsville (now Coleman), Orton found in the Rock Hill mine 20 inches of poor coal four feet below the Lower Kittanning coal.[12] Stout and Lamborn quote this section from Orton in their report on the geology of Columbiana County as the section in the old shaft along Middle Fork of Little Beaver Creek about one-half mile above Teegarden, but I am sure that it is the section in the old Maurer mine near Coleman.[13] There are three reasons for this belief: (1) Orton wrote that the mine is entered by a slope, the coal lying at and below the level of low water in the creek. Above Teegarden it is the Middle Kittanning coal that is at creek level, and the mine there to the Lower Kittanning coal was a shaft. (2) Robbinsville is the old name for Coleman. (3) Orton mentioned a destructive gas explosion in this mine, and Mr. David Reese, of Logtown, recently described to me a destructive gas explosion of many years ago in the Maurer mine in which 12 miners were killed.

Stout and Lamborn did not discuss the Lawrence coal separately in their report on the geology of Columbiana County, but they did give sections in their discussion of the Lower Kittanning clay in which the Lawrence coal and its associated clay are present and recognized. The localities given by them are in St. Clair and Yellow Creek Townships and just over the boundary line in Pennsylvania.[14] They also quoted Orton's previously cited section showing Lower Kittanning and Lawrence coals in the Rock Hill mine near Coleman and printed a picture showing the same coals along Yellow Creek near New Salisbury in Section 33, Yellow Creek Township.[15]

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[12]Orton, Ed.: *Op. cit.*, pp. 194–195.
[13]Stout, W., and Lamborn, R. E.: *Op. cit.*, pp. 104–105.
[14]*Idem.*, pp. 78, 79, and 84.
[15]*Idem.*, p. 105 and Plate III, opp. p. 184.

From all the known evidences the Lawrence coal has a wide but a somewhat discontinuous distribution in the northeastern quarter of the Lisbon quadrangle. It is generally thin and of very poor quality, being shaly and at some places pyritiferous as well. It has been prospected locally but to my knowledge has never been mined to any large extent. Its principal value is to the stratigrapher for correlation purposes.

	Number of Localities	Member	Description	Thickness
12		*Hamden*	Shale: gray, marine, argillaceous, fossiliferous	4′ 0″
11			Shale: gray to gray-black, marine, calcareous, fossiliferous; with nodular fossiliferous limestone, locally with cone-in-cone	0′ 10″
10			Shale: black, marine or brackish, bony, fossiliferous	0′ 8″
9	30	*Lower Kittanning*	Coal: with some marcasite and fusain	3′ 0″
8	8*		Clay: gray to dark gray, plastic	2′ 6″
7	8*	*Lawrence*	Coal: impure, locally absent	1′ 8″
6	2		Clay: gray, plastic, arenaceous	7′ 9″
5	4		Shale and sandstone, variable	25±′
4	4	*Vanport*	Shale: gray to dark gray, marine, variable, fossiliferous; with nodules and layers of shaly fossiliferous limestone	10±′
3	6	*Clarion*	Coal: at most places of poor quality, locally absent	1′ 4″
2	1		Clay: gray or buff stained, plastic, arenaceous	5′ 10″
1	3		Shale and sandstone	

*Used measurements from three localities given by Ed. Orton, Geol. Surv. Ohio, vol. V, pp. 33, 180, and 195. (1884.)

Fig. 5. Generalized section of exposed strata in the northeastern quarter of the Lisbon quadrangle below the Hamden shale and limestone.

SUMMARY

A composite and complete stratigraphic section of the rocks exposed below the Hamden member is given in Figure 5. The Lower Kittanning coal and overlying Hamden limestone are steady in their association and occurrence and uniform in their lithology. Hence these members are usually quite reliable but unfortunately not infallible guides in determining the stratigraphy. The last statement must be qualified because the Vanport member at two different places (see Weingart and Kenreigh sections) has nodular fossiliferous limestone in fossiliferous shale above the Clarion coal. Such a section of the Vanport and Clarion members could very easily be mistaken for the Hamden and Lower Kittanning members. The following criteria will, I believe, when fully and carefully applied, distinguish the two groups

from each other: (1) The Clarion coal averages only one-half or less of the thickness of the Lower Kittanning coal. (2) The black, bony shale or "draw slate" is poorly developed or absent above the Clarion coal. (3) The assemblage of fossils is somewhat different in the two marine members. Briefly the main faunal differences appear to be:

HAMDEN MEMBER:	VANPORT MEMBER:
1. Brachiopoda:	1. Brachiopoda:
a. *Mesolobus mesolobus* var. *euampygus*—very abundant.	a. *Mesolobus mesolobus* var. *euampygus* (*?*)—rare.
b. Large productids: *Dictyoclostus*, *Linoproductus*, *Juresania*—rare.	b. Large productids: *Dictyoclostus*, *Linoproductus*, *Juresania*—abundant.
c. *Marginifera murcatina*—very abundant.	c. *Marginifera murcatina* (*?*) — very abundant.
d. *Neospirifer cameratus*—very rare.	d. *Neospirifer cameratus*—abundant.
2. Pelecypoda: Various common genera abundant.	2. Pelecypoda: Various common genera abundant.
3. Gastropoda: Various common genera abundant.	3. Gastropoda: Various common genera very abundant.
4. Cephalopoda: Various common nautiloid genera fairly abundant; ammonoid genera rare.	4. Cephalopoda: Various common nautiloid genera fairly abundant; ammonoid genera rare.
5. Crinoidea: Stems absent.[16]	5. Crinoidea: Stems rare to moderately abundant.

The close association of the Lawrence coal with the Lower Kittanning coal can be used at some places as an aid in identifying the strata in question.

The economic value of all members described with the exception of the Lower Kittanning coal and clay and the Lawrence clay is negligible.

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[16]Recently (May, 1943), after eleven years of intermittent collecting from the Hamden member, I collected two crinoid segments from that member at the Pascola shaft in Section 33, Green Township, Mahoning County.